Upper Lake Park Beach, Port Washington, Wisconsin

Located just north of downtown Port Washington, Upper Lake Park Beach comprises the waterfront portion of Upper Lake Park (Figure 1). The city's Parks and Recreation Department maintains the beach, which is approximately 1,700 ft long and situated beneath a large bluff. In 2010, stairs were constructed from the park proper to the beach and the city now regularly grooms the beach. No lifeguards are posted and daytime visitor counts are not made; however, anecdotal information and reports from monitoring personnel indicate that visitation is moderate to heavy during the summer months.

Figure 1. *Upper Lake Park Beach, Port Washington, Wisconsin.*

The Ozaukee County Health Department is responsible for water-quality monitoring and public notification. Samples are collected four days per week (Thursday-Sunday) from two fixed stations (see Figure 1). Although two separate samples are collected, they are composited before being tested by the city drinking water utility for *E. coli*, using the standard 18-hour colilert analysis. The entire beach is posted with an advisory if the composite results exceed water-quality guidelines. In 2010, Upper Lake Park Beach was posted with two advisories and one closure. In 2011, four advisories were posted.

In 2007, the county conducted a standardized sanitary survey of Upper Lake Park Beach to determine, in part, whether *E. coli* elevations at the beach were caused by effluent discharge from the nearby Port Washington wastewater treatment plant. Intensive spatiotemporal sampling and testing revealed that the treatment plant was not contributing to contamination events and that the principal source was stormwater discharge from Valley Creek, which outfalls just to the south of the plant (Figure 1). Microbial water quality was shown to be strongly correlated with rainfall and turbidity, as well as creek flow. Based on these findings, the health depart instituted the first multi-variate, early-warning system for beach water quality in Wisconsin, known as the "Rainflow" system. Rainflow recommended whether or not to post advisories based on whether threshold levels of measured rainfall, creek flow, and turbidity were exceeded. Ozaukee County is unique among local health departments in its routine operation of a stream gage to measure flow levels in the creek discharging near Upper Lake Park, as well as an in-house turbidity meter to quantitatively measure nearshore turbidity as part of its sanitary survey work. Turbidity is the most influential factor in water-quality exceedances at Upper Lake Park, and has been shown to be highly correlated to *E. coli* levels at beaches around the Great Lakes.

Midway through the 2009 season, the Rainflow system was replaced with a statistical nowcast model developed by the Wisconsin DNR using the U.S. EPA's *Virtual Beach* version 1. This system was an updated version of the original research-and-development software and had significant limitations related to conducting operational nowcasts. For example, running daily predictions required a custom spreadsheet-based system to operate the model. Experience gained through the field-testing of this combined system proved invaluable in terms of the guidance provided to the Wisconsin DNR and U.S. EPA on how future versions of *Virtual Beach* should function to better facilitate operational nowcasting. A re-vamped *Virtual Beach* version 2.0 was released in 2010; however, it was not in time for the beach season. The original hybrid system was employed for the 2010 nowcast.

Nowcast Models

Separate nowcast models were developed for Upper Lake Park Beach for the 2011 and 2012 beach seasons, respectively. 2011 marked the first year in which the re-vamped *Virtual Beach* was used as the stand-alone system for nowcasting water quality. Both years' models were built by the Wisconsin DNR using the updated software (version 2.1 in 2011; version 2.2 in 2012). Beach monitoring staff at the Ozaukee County Public Health Department provided expert guidance and suggestions, based on their ongoing sanitary surveys. The finished models were provided as *Virtual Beach* model (.VBMX) files for local operation using the software. The full process of data assembly, model set-up, and model-building is described in detail in the report *Building Operational "Nowcast" Models for Predicting Water Quality at Five Lake Michigan Beaches*[1].

The 2011 Upper Lake Park Beach nowcast model was specified as:

LN(*Ecoli*) = -2.734 + 0.0745*(LN(PROD(*CreekFlow*, *WaterTemp_F*))) + 0.4303*(*Rain48*) + 0.9432*(LN(*NTU*)) + 0.0519*(*WaterTemp_F*) - 0.345*(PROD(*WaveHeight_ft*, *Sunny*)) + 0.176*(QUADROOT(PROD(*AirTemp_F*,*Post_Aug10*))) + 0.5388*(SQUAREROOT(*WaveHeight_ft*)) - 2.946*(*CurrentNorth*)

[1] Mednick, A.C. 2012. *Building Operational "Nowcast" Models for Predicting Water Quality at Five Lake Michigan Beaches.* PUB-SS-1098. Bureau of Science Services, Wisconsin Department of Natural Resources, Madison.

The 2012 Upper Lake Park Beach nowcast model was specified as:

LOG10(*Ecoli*) = -3.23 + 0.06899*(*WaveHeight_ft*) + 0.5437*(POWER(*NTU*,0.3333333)) + 0.4524*(POLY(*Gulls*,1.1391227,-0.0088228638,9.7708626e-05)) + 1.035*(POLY(*CurrentO_comp*(CSPD,CDIR,31.71),1.0632748,-1.1696592,59.751572)) + 0.0003058*(PROD(*NTU*,*RRAIN*48)) + 0.3368*(SQUAREROOT(*WTEMP*)) + 0.351*(*WaveO_comp*(WVHT,WVDIR,31.71)) + 0.0001457*(SQUARE(*WaterTemp_F*)) - 0.01177*(QUADROOT(*RRAIN24*)) + 0.3087*(*AlgBch_high1_0*)

Where:

Ecoli = *E. coli* (MPN/ 100mL) — Measured by the Ozaukee Co. Pub. Health Dept.
AirTemp_F = Air Temperature (deg. F) — Measured by Ozaukee Co. Pub. Health
AlgBch_high1_0 = Algae on beach "high"? (y=1/ n=0) — Ozaukee Co. Pub. Health
CreakFlow = Valley Creek flow (100 gal/day) — Ozaukee Co. Public Health Dept.
CurrentNorth = Surface Water Velocity towards 0° (meters/sec) — GLCFS, NOAA
CurrentO_comp = Onshore Current (meters/sec) — Derived from:
    Surface Current Velocity (meters/sec) — GLCFS, NOAA
    Surface Current Direction (toward 0-360 deg.) — GLCFS, NOAA
Gulls (count of birds) — Ozaukee Co. Pub. Health Dept.
NTU = Turbidity (NTU) — Ozaukee Co. Pub. Health Dept.
Post_Aug10 = After to August 10th? (y=1/ n=0)
RAIN48 = Rainfall, 48 hours (in) — Port Washington Wastewater Treatment Plant
RRAIN24 = Rainfall, 24 hours (mm) — Radar Est. from the North Central River Forecasting Center, NOAA
RRAIN48 = Rainfall, 48 hours (mm) — Radar Estimated… NOAA
Sunny = Sky condition (y=1/ n=0) — Measured by the Ozaukee Co. Pub. Health Dept.
WaveHeight_ft = Wave Height (ft.) — Measured by the Ozaukee Co. Pub. Health Dept.
WaveO_comp = Onshore Waves (meters) — Derived from:
    Significant Wave Height (meters) — GLCFS, NOAA
    Wave Direction (from 0-360 deg.) — GLCFS, NOAA
WaterTemp_F = Water Temp. (deg. F) — Measured by Ozaukee Co. Pub. Health Dept.
WTEMP = Water Temperature (deg. C) — GLCFS, NOAA

And where:

LOG10 = logarithm, base 10
LN = natural logarithm
POLY = polynomial transformation ($a + bX + cX^2$)
PROD = *X1* * *X*2
QUADROOT = $X^{1/4}$
SQUARE = X^2
SQUAREROOT = $X^{1/2}$

Nowcast Model Operation

Beach monitoring staff at the Ozaukee County Health Department operate the Upper Lake Park Beach nowcast. The process of running the nowcast generally takes the operator five minutes or less per day, on top of routine beach monitoring and public notification activities. Nowcast model runs are conducted after monitoring personnel return to the health department office after collecting water samples and taking routine sanitary survey measurements at the beach (Figure 2) and recording flow in the nearby Valley Creek. On many days the nowcast operator is the same staff person who has conducted the field work. For parts of the season, summer interns may conduct the fieldwork and provide the nowcast operator with the needed input values recorded on standardized paper forms. Routine sampling and sanitary surveys take place around 07:00 a.m. CDT, allowing for ample time to run the model and post an advisory, if deemed necessary, by mid-morning. One additional step that is conducted for Upper Lake Park Beach is the measurement of actual turbidity, as opposed to a visual/subjective estimation of water clarity. A turbidity meter (Figure 3) is used to quantitatively measure the turbidity of water in nephelometric turbidity units (NTU).

Figure 2. *Transporting water-quality samples, Upper Lake Park Beach, Port Washington.*

Figure 3. *Turbidity meter used by Ozaukee County Public Health Department.*

In 2011, the procedure for running the model was for the operator to open the *Virtual Beach* model (.VBMX) file on their PC and manually enter the day's input values into the *Virtual Beach* MLR Prediction tab. This was often done at, or around, the same time as the day's sanitary survey measurements and/or lab results were uploaded to the *Wisconsin Beach Health* website (Figure 4). Manually entered data included measurements that had just been taken in the field: *WaterTemp* (degrees F), *AirTemp* (degrees F), *WaveHeight_ft* (estimated ft), *NTU* (turbidity), and *Sunny* (1 if sky "sunny"…), as well as a stage-of-season marker: *Post_Aug10* (1 if after August 10th, 0 if not). Input data also included *RAIN24* and *RAIN48* (inches of rain recorded at the Port Washington water treatment plant over the 24 and 48 hours prior to 07:00 a.m. CDT), as well as *CurrentNorth* (velocity of surface water movement towards [+] or away from [–] 0° due north, estimated by NOAA-GLCFS). The nowcast operator accessed these last three data inputs via the web, using beach-specific links posted on the *Wisconsin Beach Health* website (Figure 5), and copied the values into the MLR Prediction tab. Once all of the input values were entered, the operator executed the model.

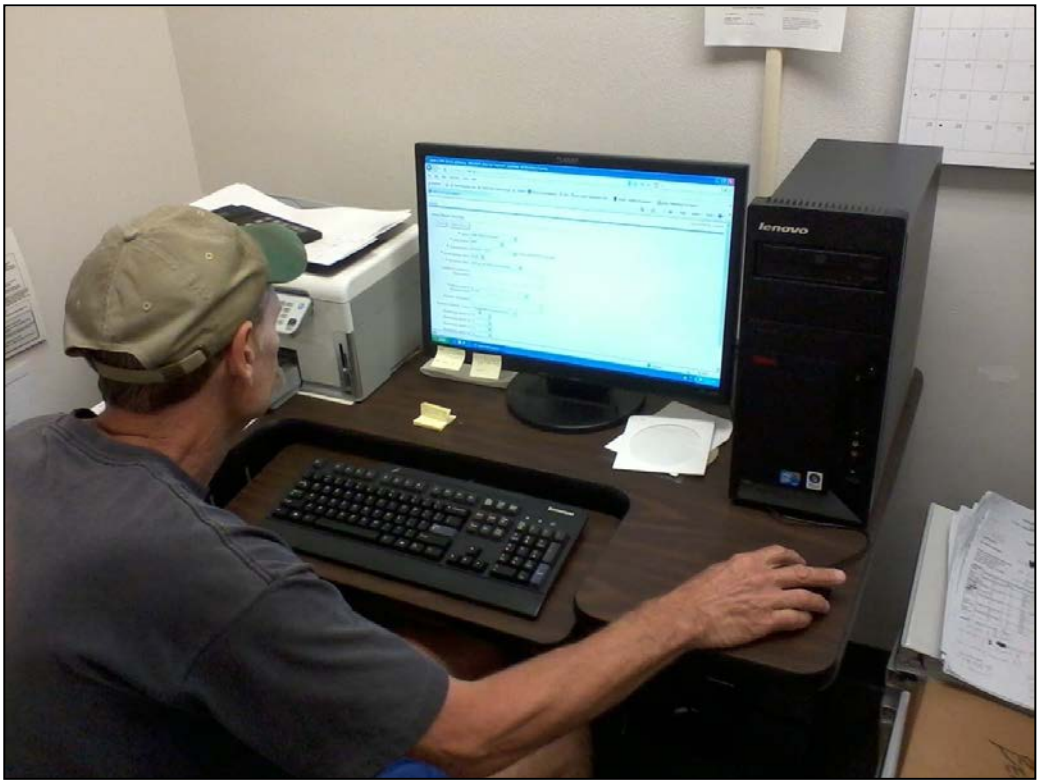

Figure 4. *Uploading routine sanitary survey data to the Wisconsin Beach Health website.*

Real-Time Data Links for:

Upper Lake Park Beach

Ozaukee County EPA ID: WI652173

Weather Conditions: PORT WASHINGTON
http://glos.us/obs/station/3-22.html
(Default time zone is GMT. Can change to CDT.)

24-hr. Rainfall: PORT WASHINGTON
http://www.crh.noaa.gov/product.php?site=MKX&product=HYD&issuedby=MKX
(Search for: " PTWW3")

Lake Level: MILWAUKEE
http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=9087057 Milwaukee, WI&type=Great+Lakes+Water+Level+Data

Surface Current and Waves: Nearest GLCFS Cell *Lat:* 43.38675 *Lon:* -87.84885
http://michigan.glin.net:8080/glcfs/glcfsps.glos?lake=michigan&i=-87.84885&j=43.38675&v=uc,vc,wvh&h=1&latest=3&tzf=-5&f=rss&u=m&pv=1&order=dec

Tributary Discharge: SHEBOYGAN RIVER AT SHEBOYGAN, WI
http://waterdata.usgs.gov/nwis/uv?cb_00060=on&format=html&period=1&site_no=04086000

Note: The Web links listed above represent the nearest stations that regularly report real-time data. Distances between the beach and stations varies from site to site. "Surface Current and Waves" are model estimates from the Great Lakes Coastal Forecast System (GLCFS): www.glerl.noaa.gov/res/glcfs/

Return to Wisconsin Beach Health main page

Internet | Protected Mode: On 100%

Figure 5. *Real-time data links for Upper Lake Park, posted on Wisconsin Beach Health website* (www.wibeaches.us/real_time_data_links/RTD_Ozaukee_Upper%20Lake%20Park.html).

The procedure for running the 2012 nowcast model was somewhat different, allowing for additional "automated" data inputs via the U.S. Geological Survey's *Environmental Data Discovery and Transformation* (ENDDAT) system [2]. The nowcast operator used a custom ENDDAT web URL (developed by Wisconsin DNR staff) to download a one-row table of the most recent values of several model inputs, including: *RRAIN24* (millimeters of rain estimated by radar over the past 24 hours), *Significant Wave Height* (meters) and *Direction* (0-360 degrees), and *DOY* (day of year, 1-365). The daily ENDDAT table was then imported into the *Virtual Beach* MLR Prediction tab, leaving the operator to manually-enter the remaining values: *AlgBch_None* (1 if there is any algae on the beach, 0 if none), *Gulls* (estimated number of gulls on the beach), *ClearWater* (1 if water "clear"…), *Sunny* (1 if sky "sunny"…), and *July16_Aug10* (1 if between these dates…). Once all of the input values were entered, the operator executed the model to make a prediction (Figure 6).

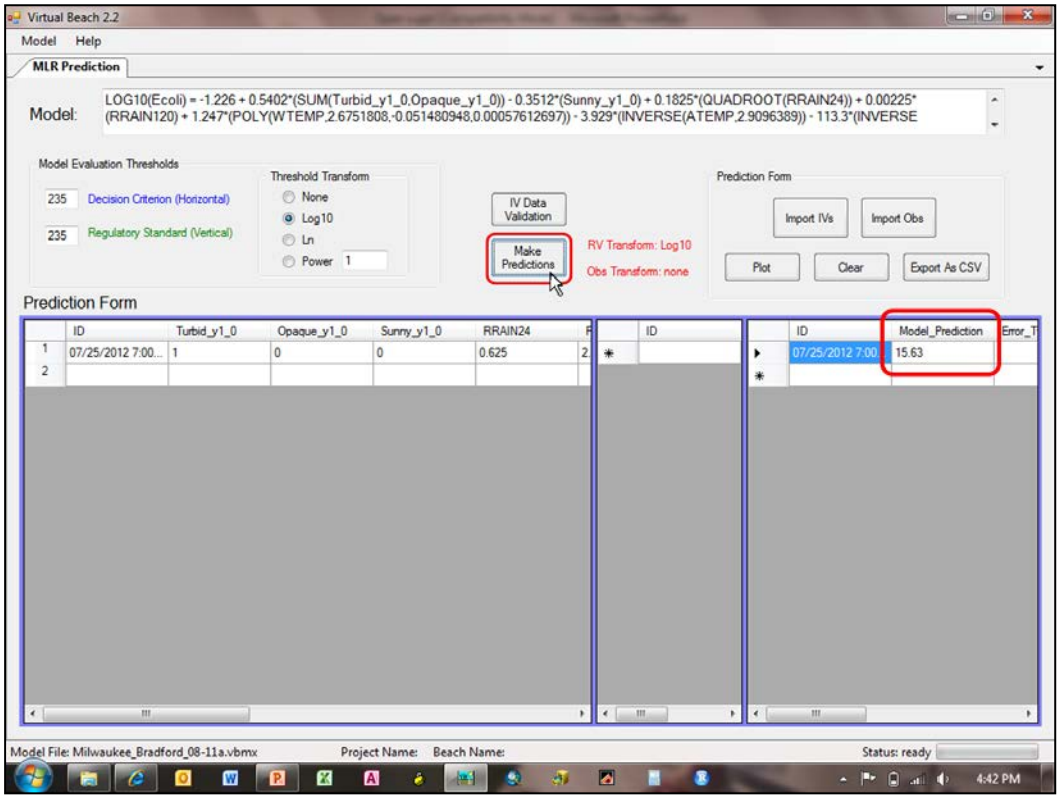

Figure 6. *Virtual Beach's "MLR Prediction" tab.*

Outputs of the nowcast included both the estimated concentration of *E. coli* and the statistical probability of exceeding the 235 CFU/100 mL water-quality standard. Health department staff primarily used the estimated *E. coli* concentrations to determine whether or not to post swim advisories or closures at the beach.

[2] http://cida.usgs.gov/enddat/

Nowcast Results

The 2011 Upper Lake Park Beach nowcast was operated from June 23 through September 5. During that period, the model correctly predicted water-quality exceedances resulting in the posting of two swim advisories that otherwise would have been missed. In addition, the model predicted non-exceedances resulting in one avoided advisory and one avoided closure that otherwise would have been issued (based on the previous day's lab results). The 2012 nowcast was only run in operational mode from August 11 through September 3, having performed poorly (in evaluation mode) during the early part of the season, before being rebuilt to account for extreme hydro-meteorological conditions and to improve sensitivity to dry-weather/clear-water *E. coli* elevations. During this shortened period of operation, however, the model predicted water-quality exceedances resulting in the posting of two swim advisories that otherwise would have been missed. In addition, the model predicted non-exceedances resulting in two avoided swim advisories that otherwise would have been posted (based on the previous day's lab results).

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